1 Introduction

1.1 Background on Global Climate Change

The composition of the Earth's atmosphere is a primary determinant of the planet's temperature, which in turn affects all life on Earth. Greenhouse gases occur naturally and trap heat within the atmosphere, helping to keep the planet hospitable to life. The main greenhouse gases are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halocarbons (such as chlorofluorocarbons, or CFCs). According to the US Department of Energy (DOE), concentrations of greenhouse gases in the atmosphere have noticeably increased over the past one hundred years.[1]

Global climate change—often referred to as "global warming"—involves an increase in the average atmospheric temperature of the Earth. Such a temperature increase does not mean that temperatures will rise by a few degrees in all locations around the world. Rather, were global warming to occur, increases in atmospheric and oceanic temperatures might raise sea levels and alter associated weather patterns, which in turn could increase the frequency and severity of extreme weather worldwide. Such changes would likely alter current patterns of land use and human activity, as well as ecosystems and natural habitat.[2]

The ability to reliably predict global climate change involves some uncertainties with regard to magnitude, timing, and location.[3] However, the Intergovernmental Panel on Climate Change (IPCC), a group of the world's leading scientists, believes the increase in atmospheric concentrations in part can be attributed to human activities, such as emissions of greenhouse gases and deforestation.[4] The IPCC and many scientists believe that global climate change and its potentially disruptive effects are likely to occur unless we reduce greenhouse gas emissions.[5]

Despite the uncertainties as to the metes and bounds of future global climate change, including rising sea level and increased potential for drought, numerous governments agree that the risk of inaction is sufficient to justify nations to take action. At a conference held in December 1997 in Kyoto, Japan, the Parties to the UN Framework Convention on Climate Change (developed during the "Earth Summit" in Rio de Janeiro in June 1992) agreed to an historic Protocol calling for binding emission targets for developed nations to reduce greenhouse gas emissions.

The Kyoto Protocol in key respects reflects proposals advanced by the United States. In particular, the Protocol allows for the use of international emissions trading, in which countries or companies can purchase less expensive emissions permits from countries that have room to spare in meeting their targets. This market-based approach, pioneered in the US, should allow countries to seek out the cheapest emissions reductions, substantially lowering costs of compliance. In addition, emission targets are to be reached over a five-year budget period, as proposed by the US (the first budget period being 2008-2012), rather than by a single year. Emissions targets include six major greenhouse gases, and activities that absorb carbon, such as planting trees, can be used to offset emission targets.

Continuing policy development is likely to place additional analytical demands on Federal agencies, including the Department of Transportation (DOT), as the US government moves from general support to specific policies and activities to achieve targets. A global greenhouse gas trading program poses additional analytical challenges. If the US experience in other emissions trading programs holds true under global trading of greenhouse gases, the amount of reductions achieved by the US or the transportation

sector could change from what it might have been under a no-trading scenario. A trading program for greenhouse gas reductions could provide another alternative to measures such as those discussed in Chapter 5 of this report. Rules and guidelines for verification, reporting, and accountability are to be discussed at the next meeting of the Parties at Buenos Aires in November 1998.

1.2 PURPOSE

This report provides a discussion of the relationship between transportation and global climate change, based on peer-reviewed literature and research findings. The report presents an overview of policy debates, scientific conclusions, unresolved issues, and strategies available as potential solutions. The principle focus of the report is to better identify an array of tools and highlight aspects of these tools that may be useful to DOT as it begins to develop a strategy for addressing the link between transportation and climate change.

The overall purpose of the report is to provide an overview of global climate change and review how transportation agencies may assist in reducing CO_2 and other greenhouse gas emissions from transportation sources. Federal, state, and local transportation and air quality agencies have already made advances toward attainment of the national ambient air quality standards, but have not yet pursued mitigation of greenhouse gases, since no legal/administrative approaches have yet become finalized.

This report is organized in four primary sections:

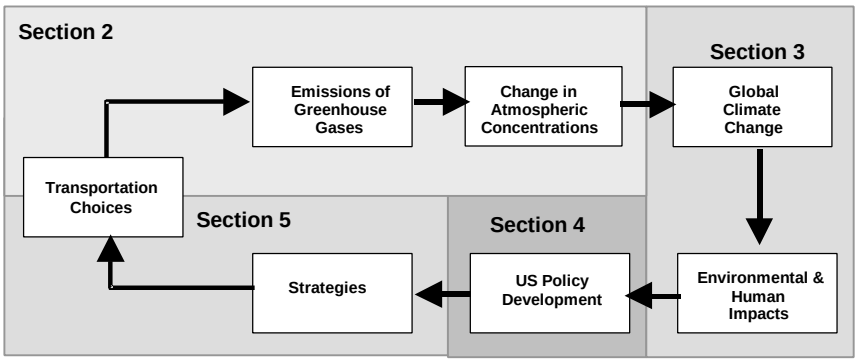
- Inventories of Emissions and Concentrations—The report begins by describing the sources of emissions and data on greenhouse gas concentrations; this section addresses the questions, how much are we emitting? What are the sources? What are the atmospheric concentrations?
- Potential Impacts of Global Climate Change—This section highlights the state of scientific knowledge regarding impacts, and addresses the questions, what may be happening? Should we care?
- Developments in Global Climate Change Policy—This section summarizes recent international and domestic debates and policies regarding climate change. It addresses the question, what is the global and national context in which to consider specific strategies to reduce emissions?
- Strategies to Reduce Greenhouse Gas Emissions—This section highlights strategies relevant to reducing emissions from the transportation sector; it addresses the questions, what are we currently doing to address greenhouse gas emissions? What alternative strategies exist?

The strategies discussed within this report focus predominantly on highway transportation associated with personal travel in single occupant vehicles (SOVs). This is done simply because there is more peer-reviewed literature on this subject in terms of vehicle technology and driver behavior; other strategies may prove to be as effective or more so upon implementation. In addition, more information is currently available regarding energy consumption and greenhouse gas emissions related to highway transportation.

An annotated bibliography (Appendix C) allows the reader to refer to some of the major publications on the subject.

The primary sections of this report are identified in the following exhibit, which outlines a framework for examining the issues related to transportation and potential global climate change.

Exhibit 1-1. Framework for Examining Transportation and Potential Global Climate Change



This framework is useful for characterizing the potential linkages between activities, emissions, and global climate change. Debate focuses around the certainty regarding links between boxes. Scientific debate concerns the links between anthropogenic emissions and changes in atmospheric concentrations of greenhouse gases, the effects of atmospheric concentrations on global climate, and the consequences of changes in global climate on the environment and human activity. Policy debate centers on the effectiveness of various strategies at reducing emissions, the costs and feasibility of pursuing particular actions, and the setting of proper targets. This report begins with a preliminary discussion of the issues pertaining to greenhouse gas emissions inventories and concentrations.

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[1] *See, e.g.*, US Department of Energy, Energy Information Administration, Office of Integrated Analysis and Forecasting, *Emissions of Greenhouse Gases in the United States, 1987-1994* (Pittsburgh, PA: US Government Printing Office, October 1995), p. 2.

[2] *See, e.g.*, US Congress Office of Technology Assessment, *Preparing for an Uncertain Climate, Vol. I, II* (Washington, DC: US Government Printing Office, 1993), for a discussion of the range of potential impacts from climate change.

[3] *See, e.g.*, George C. Marshall Institute, *Are Human Activities Causing Global Warming?* (April 1996). (US DOE, 1995, pp.2-3).

[4] Intergovernmental Panel on Climate Change, *Second Scientific Assessment of Climate Change, Summary and Report*, World Meteorological Organization/UN Environment Program (Cambridge, UK: Cambridge University Press, 1995).

[5] *See, e.g.* US Environmental Protection Agency, *Policy Options for Stabilizing Global Climate: Report to* Congress, EPA No. 21P-2003.1 (December 1990); Intergovernmental Panel on Climate Change, *Second Scientific Assessment of Climate Change, Summary and Report*, World Meteorological Organization/US Environment Program (Cambridge, UK: Cambridge University Press, 1995).